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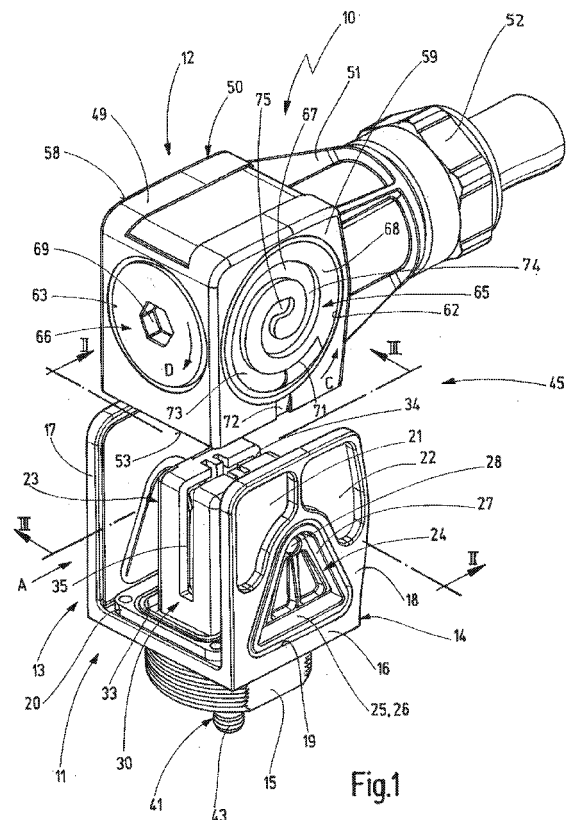
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(54) **Plug-in connector device**

(57) A plug-in connector device (10) for systems of high power density is provided with a first (female) plug-in unit (11), a second (male) plug-in unit (12), and a locking device (45) for the joining together, i.e., pulling together, and the force- or form-fitting holding of the first and second plug-in units (11; 12), which engage in and over each other when plugged into each other. To achieve an optimal construction size and good access for maintenance purposes, the locking device (45) is formed by at least one disk element (64, 65), which is supported on the first or second plug-in unit (11; 12) so that it can be rotatably driven, and by at least one cam (28) on the second or first plug-in unit (12; 11), said cam engaging in a curved track (67) of the disk element (64, 65) in a motion-locking manner.



Description

[0001] The present invention relates to a plug-in connector device, in particular for systems of high power density, in accordance with the preamble to Claim 1.

[0002] In order to be able to transmit high currents, contacts in high-performance plug-in connector devices are used that feature high contact forces and large plug-in forces, associated therewith. Usually these plug-in connector devices are joined together using supplemental devices such as locking nuts along with a bayonet groove or an activation lever with corresponding contours. These supplemental devices require comparatively large installation space because they require large activation paths to achieve sufficiently effective force amplification.

[0003] High-performance plug-in connector devices are in demand most of all in the automotive industry for electrically operated vehicles, by way of example, where manufacturing costs represent a significant criterion, on the one hand, and the installation space in vehicles is very limited by their very nature, on the other hand. Nevertheless, good access is necessary for maintenance purposes. In addition, unauthorized access to the plug-in connector device should be prevented, or any successful intrusion should be indicated.

[0004] It is the objective of the present invention to create a plug-in connector device of the aforementioned type, which can be used despite the limited scope of the vehicle installation space while preserving good access for maintenance purposes, and which is technically simple in production terms.

[0005] To achieve this objective in a plug-in connector of the aforementioned type, the features indicated in Claim 1 are provided.

[0006] As a result of the measures according to the present invention, an activation path is traversed in a simple manner by a rotatable disk element on one of the plug-in units, whereby a cam on the other plug-in unit engages in the curved track of the disk element. In this way, by simply rotating the disk elements, the two plug-in units may be fitted together, i.e., pulled together, forcefully over a relatively long activation path during the plug-in process.

[0007] According to one preferred exemplary embodiment, the features in accordance with Claim 2 are provided so that a smooth plug-in process is assured due to the symmetrical arrangement and mode of action of the two disk elements.

[0008] On the basis of the features of Claim 3 and/or 4, a curved track is achieved that is simple to activate, on the one hand, and the possibility is gained, on the other hand, of achieving a force amplification based on the changing slope of the curved track towards the end of the activation path.

[0009] In a particularly advantageous manner, according to the features of one or more of Claims 5 to 7, the disk elements are not only carriers of the curved track

but at the same time also form parts of a gear mechanism which transmits the input drive motion, imparted by a tool, from the drive pinion to the output drive gear wheels, which are identical in construction, in parallel and at the same magnitude. In other words, the output drive wheels, preferably in the form of crown wheels, are also configured for the two aforementioned modes of operation. The disk elements, i.e., the gear wheels, can be advantageously manufactured of plastic using injection molding processes, which keeps the manufacturing costs low, given the anticipated quantities. Based on the gear mechanism geometry, the crown wheels, which are driven in opposite directions, can be identical. In order to prevent unauthorized access, the drive pinion is advantageously provided with a tool access that advantageously deviates from the standard type.

[0010] The features according to Claim 8 are advantageously provided, resulting in a space-saving arrangement, i.e., the accommodation of the disk elements, i.e., the crown wheels and the drive pinion, within the exterior housing of the relevant plug-in unit.

[0011] If the features according to Claim 9 are provided, then especially good force amplification results because gear reduction is also ensured by the selection of the diameter ratios.

[0012] The features according to Claim 10 are advantageously provided, resulting in a small-sized design for this second plug-in unit, by way of example.

[0013] Advantageous embodiments with respect to the arrangement of the cams in the first plug-in unit, for example, can be seen from the features of one or more of Claims 11 to 13. In this way, the cams are guided so that they can be deflected in an elastically resilient manner and can be axially pre-stressed in the relevant curved track. In this context, the latching elements, including the cams, are integrated by means of an opening in the electrically conductive wall parts so that they are locked in place therein.

[0014] Advantageous embodiments with respect to the electrical contact arrangement within this first plug-in unit may be seen in the features according to Claim 14 and/or 15.

[0015] In accordance with the features of Claim 16, during the plug-in process the wall parts of the first plug-in unit engage over the relevant side walls of the second plug-in unit.

[0016] Further details of the invention may be seen in the following description, in which the invention is described and explained in greater detail on the basis of the exemplary embodiments that are depicted in the drawing. In the drawing:

Figure 1 in a perspective representation depicts a first (female) plug-in unit as well as a second (male) plug-in unit of the plug-in connector device according to one preferred exemplary embodiment of the present invention,

Figure 2 depicts a cutaway view along the line II-II in the first plug-in unit shown in Figure 1,

Figure 3 depicts a cutaway view along the line III-III in the first plug-in unit shown in Figure 1,

Figure 4 in a perspective and cutaway representation depicts the second plug-in unit in order to represent a drive mechanism for a force-fitting plug-in connection of the two plug-in units,

Figure 5 in a perspective representation depicts a pre-connection step in the electrically conductive plug-in process of connecting the first and second plug-in units of the plug-in connector device in accordance with the preferred exemplary embodiment of the present invention depicted in Figure 1,

Figure 6 depicts a cutaway view along the line VI-VI in Figure 5, but in a completely plugged-together state of first and second plug-in units,

Figures 7A and 7B each in a perspective representation depict two variants of a second exemplary embodiment of a second plug-in unit having a two-part housing,

Figures 8A and 8B in a perspective representation each depict one of the two parts of the housing of the second plug-in unit according to the second exemplary embodiment,

Figures 9A and 9B each in a perspective representation depict two variants of a third exemplary embodiment of a second plug-in unit that is similar to Figures 7A and 7B, but in a multi-pole embodiment,

Figures 10A and 10B in a perspective representation each depict one of the two parts of the housing of the second plug-in unit according to the third exemplary embodiment, and

Figure 11 depicts a first plug-in unit in a multi-pole embodiment for the electrically conductive plug-in connection with one of the second plug-in units shown in Figures 9A and 9B.

[0017] Electrical plug-in connector device 10, 110, 210, as depicted in the drawing in accordance with several exemplary embodiments, is designed especially for plug-in connections of high transmission power, i.e., high specific power density, as is the case in electrically operated motor vehicles, for example.

[0018] Figures 1, 2, and 3 show a first (female) plug-in unit 11, which can be used both in a plug-in connector device 10 according to Figures 1, 5, and 6, as well as in a plug-in connector device 110 according to Figures 7 and 8, along with a second (male) plug-in unit 12 (Figures

1 and 4) and 112 (Figures 7 and 8).

[0019] First plug-in unit 11 has an open housing 13 that is made of any material, said housing being made of an electrically conductive material or being provided with an electrically conductive layer in the event an electromagnetic shielding is part of the design, whereby housing body 14 when seen in a front view A has a U-shaped configuration and is integrally provided with an external threaded projection 15 for through-hole mounting on a fixed component. Housing body 14 has a base 16, on each of whose two opposite longitudinal sides an identical, vertically protruding wall part 17, 18 protrudes as an integral part. Both parallel wall parts 17, 18 face base 16 and are furnished with a through-opening 19 that is trapezoidal or triangular in shape and, above said through-opening 19, with recesses 21, 22 that proceed from the exterior side. Facing away from both wall parts 17, 18, base 16 on its lower side is provided with integral external threaded projection 15.

[0020] A latching element 23, 24, made of plastic, for example, and having the shape of through-opening 19, is introduced into a through-opening 19. Base area 25 of each latching element 23, 24 is held in latching fashion within through-opening 19 and is weakened in its thickness by a hollow groove 26, forming a film-like hinge, so that triangular area 27 above base area 25 is supported in such a way that it can be deflected in an elastically resilient manner. In the apex area of each latching element 23, 24, a latching cam 28 is molded so as to point to the interior of housing body 14.

[0021] Within housing body 14, an electrical insulating-material body 30 is arranged, which accommodates a female contact arrangement 35, is made of electrically conductive material, and is positioned over an essentially longitudinal area of both wall parts 17, 18 of housing body 14, being centrally located between the latter, so that it penetrates cutouts 31, 32, and 33 that are located in base 16, external threaded projection 15, and a rubber seal 20 that contacts base 16. With its end facing away from wall parts 17, 18, said electrical insulating-material body essentially terminates in alignment with the annular end of external threaded projection 15. Insulating-material body 30 may be slid between wall parts 17, 18 through cutouts 31 to 33 and may be held between external threaded projection 15 and seal 20 in latching fashion.

[0022] Female contact arrangement 35, employed in the exemplary embodiment depicted, is made up of two packets that are arranged next to each other with spacing and are made up of multiple metal spring contacts 36. Spring contacts 36, which in the exemplary embodiment are configured so as to be identically cut from flat metal plate, each have two parallel, elastically deflectable legs 37, which have a U-shape, form a receiving slot 44 between them, and are supported on a base 38, which is provided with a through borehole 39. By means of through boreholes 39, spring contacts 36, which are arranged next to each other and are individually provided with contact points 36', are lined up on a tubular metal

carrier 40 and are attached by being strung in packets so as to be in close contact with each other. One end of a holder 41, whose other end 43 is configured as an external threaded pin, is fixedly supported on tubular carrier 40 in the center between the two packets of spring contacts 36. An annular collar 47, by which contact arrangement 35 is guided within the lower area of insulating-material body 30, is integrally provided between both ends 42, 43. A locking hook 46, which facilitates the locking of contact arrangement 35 within insulating material body 30, is attached between the two adjacent packets of spring contacts 36 on tubular carrier 40.

[0023] Figures 1 and 4 to 6 show the second (male) plug-in unit 12 according to one preferred exemplary embodiment, having a roughly cuboid housing 50, which is provided with a plug-in aperture 53 on a side wall or end wall for accommodating first (female) plug-in unit 11. On a second end face, housing 50 is furnished with a bushing 51 and a cable strain relief device 52, in the form of a screw connection, for example, for accommodating a connecting unit of a second (male) electrical contact arrangement 55, which can be, or has been, connected to the stripped cable end, and which is configured in the form of a blade contact 56 in the exemplary embodiment.

[0024] Housing 50 has a hollow body 49 that can be made of any material, said housing being made of an electrically conductive material or being provided with an electrically conductive layer in the event an electromagnetic shielding is part of the design, said housing body, if it is made of electrically conductive material, being lined with an insulating material that is not represented in detail and having cutouts 61, 62, 63, on two opposite longitudinal side walls 58, 59 and on an end wall 60, connecting both longitudinal side walls 58, 59, into which a gear wheel 64, 65, 66 is inserted so that it can rotate. Cutouts 61, 62, 63 are advantageously configured as bearing shells that are incorporated into the relevant wall. In the exemplary embodiment, gear wheels 64 to 66 are configured as crown wheels having toothed rims 64', 65', 66' that point to the interior of housing body 49. Both opposite, parallel-arranged gear wheels 64, 65, which can also be designated as output drive gear wheels, have a toothed rim of a greater diameter than input drive gear wheel 66, which is arranged on the end face side and whose toothed rim engages both with one gear wheel 64 and with other gear wheel 65, so that both, identical output drive gear wheels 64, 65 rotate in opposite directions in accordance with arrows B and C, provided that input drive gear wheel 66 is moved in direction D (or vice versa). In this way, gear wheels 64 to 66 constitute a reduction gear.

[0025] Input drive gear wheel 66, which can move in the axial direction, has on its exterior side a tool receptacle 69, by means of which input drive gear wheel 66 may advantageously be rotated using a special tool in one direction (arrow D) or the other (opposite arrow D). Both output drive gear wheels 64, 65, on their disk surface 68 facing outside have a curved cam track 67 of identical

configuration. Curved track 67 facilitates the reception of latching cam 28 of latching element 23, 24 in housing body 14 of first (female) plug-in unit 11, as will be described below on the basis of Figures 1, 5, and 6. Curved track 67 has an access area 71, which in an initial rotational position of gear wheel 64, 65 is aligned with a groove 72 that emerges from a longitudinal edge of side wall 58, 59. Adjacent to said access area is an area 73 having a relatively gentle slope and beyond that an area 74 having a somewhat steeper slope. Curved track 67 terminates in a linear area 75 which functions as a limit stop. In this way, gear wheels 64, 65 serve a double function.

[0026] As can be seen from the preceding design explanations with regard to both plug-in units 11, 12, plug-in units 11, 12 may be joined to form plug-in connector device 10 by being brought into and over each other, whereby the joining together and the force-fitting holding together are accomplished by a locking device 45, which is constituted by interpenetrating components 23, 24, 28, and 64, 65, 67 on first plug-in unit 11 and second plug-in unit 12, respectively.

[0027] Proceeding from Figure 1, in which the initial state is depicted for the plug-in connecting process of both plug-in units 11 and 12, in a first step according to Figure 5, by way of example, with a first (female) plug-in unit 11 being fixedly held, second (male) plug-in unit 12 is brought with the open side 53 of housing body 50 between the former's two wall parts 17, 18 and over insulating-material body 30. In this context, said two longitudinal side walls 58, 59, which are furnished with gear wheels 64, 65, are inserted into the spaces between insulating-material body 30 and respective wall part 17, 18 in such a way that both latching cams 28 within wall parts 17, 18 move via side-wall groove 72 into adjacent linear access area 71 of curved track 67, which has been placed in the appropriate position. In this context, latching cams 28 contact the base of curved track 67 and are elastically pre-stressed. In this preparatory plug-in state, depicted in Figure 5, the front, free ends of spring contacts 36 are still positioned within the entry area of housing body 49 and therefore are still not in contact with blade contact 56.

[0028] To create the electrically conductive connection of the two, i.e., to complete the plug-in process between both plug-in units 11, 12, preferably using a special tool, input drive gear wheel 66 on second (male) plug-in unit 12 is rotated via tool receptacle 69 in corresponding direction D. The result is that, based on the motion-locking guidance of latching cam 28 within curved track 67, a further plug-in motion of second (male) plug-in unit 12 into first (female) plug-in unit 11 is caused, until latching cams 28, which are guided within curved tracks 67, come into contact with linear end 75 of curved track 67. Due to the shape of curved track 67, a kind of bayonet locking projected into the plane is achieved in the corresponding force-fitting, final locking state. In this position, blade contact 56, which penetrates through a slot arrangement 34 in insulating-material body 30 into the latter, is completely

held between the two packets of spring contacts 36, or on their contact points 36', which are elastically pre-stressed.

[0029] In the end state of the plug-in connection, an electromagnetic shielding of the contacting is achieved by a material-based configuration of housing bodies 14, 49 of both plug-in units 11, 12 and of seal 20, which are made of, or employ a layer that is made of, an electrically conductive material.

[0030] The plug-in connection is correspondingly disengaged in reverse fashion, i.e., by counter-rotating input drive gear wheel 66, which results in disengaging the electrical contact between electrical blade contact 56 and electrical spring contacts 36.

[0031] If a second (male) plug-in unit 12 is described in the case of the preferred exemplary embodiment depicted, in which there is a right angle between cable bushing 51 and plug-in aperture 53 for first (female) plug-in unit 11, it is obvious that second (male) plug-in unit 12 may also be configured in linear fashion, so that a plug-in connector device 10 is provided that is in linear alignment instead of being at a right angle.

[0032] Figures 7 and 8 indicate a further (second) exemplary embodiment of a second (male) plug-in unit 112, in which body 149 of cuboid housing 150, which is open on one side, is configured in two parts in such a way that two housing parts 181, 182 are created that are divided at a 45° angle. Division plane 180 of housing body 149 is vertical on its central longitudinal plane 179 and runs on a 45° diagonal between two corner edges. Depending on how the housing parts are joined, the direction of cable-accommodating bushing 151 and the plug-in direction, i.e., the direction of plug-in aperture 153 for first (female) plug-in unit and mating plug-in unit 11, run either perpendicular to each other, as shown in Figure 7A, or in a linear, i.e., 180° arrangement, as shown in Figure 7B.

[0033] According to Figure 8A, housing part 181 is provided with bushing 151 and has in its central interior area a frame part 183 as contact protection, within which blade contact 56, not depicted here, is accommodated. Frame part 183 also facilitates the guided accommodation of second housing part 182, which is depicted in Figure 8B and which has corresponding guide grooves 184 for frame part 183 and plug-in aperture 153. Therefore, rectangular blade contact 56 faces plug-in aperture 153 either with its longitudinal edge (Figure 7A) or with a free front edge (Figure 7B). Cutouts 161, 162 for undepicted gear wheels 64, 65 are indicated accordingly and are shaped in the form of bearing shells. The cutout for the input drive gear wheel is provided either on a front side 160 (Figure 7A) or on a longitudinal side 158 (Figure 7B) between cutouts 161, 162.

[0034] Figures 9 and 10 depict a further (third) exemplary embodiment of a second (male) plug-in unit 212 for a multi-pole plug-in connector device 210. This multi-pole, second plug-in unit 212 is essentially formed by creating a lateral row of single-pole, second plug-in units 12, whereby multi-pole, second plug-in unit 212, depicted

here, is formed by creating a row of multiple (in this example, three) second plug-in units 112 in accordance with Figures 7 and 8. In other words, this multi-pole, second plug-in unit 212, as was the case with second plug-in unit 112 which was designed as a single-pole device, is divided in its housing body 249 into two housing parts 281, 282 along division plane 280 at an angle of 45°, in such a way that, in accordance with Figures 9A and 9B, the choice exists as to whether the direction of cable bushing 251 and the direction of insertion, i.e., the direction of plug-in aperture 253 in a first (female) plug-in unit 211 and a mating plug-in unit (Figure 11), are arranged perpendicular to each other or in linear fashion (180°).

[0035] Figure 11 shows a multi-pole, first (female) plug-in unit 211, which is essentially based on multiple first (female) plug-in units 11, preferably on a common base plate 286 without wall parts. Multi-pole, first plug-in unit 211 is the mating plug-in unit for aforementioned multi-pole, second plug-in unit 212.

Claims

1. A plug-in connector device (10, 110, 210), in particular for systems of high power density, having a first, for example, female plug-in unit (11), a second, for example, male plug-in unit (12, 112, 212), and a locking device (45) for the joining together, i.e., pulling together and the force- or form-fitting holding of the first and second plug-in units (11; 12, 112, 212) which engage in and over each other when plugged into each other, wherein the locking device (45) is formed by at least one disk element (64, 65), which is supported on the first or second plug-in unit (11; 12, 112, 212) so that it can be rotatably driven, and by at least one cam (28) on the second or first plug-in unit (12, 112, 212; 11), said cam engaging in a curved track (67) of the disk element (64, 65) in a motion-locking manner.
2. The plug-in connector device as recited in Claim 1, wherein the locking device (45) has two parallel disk elements (64, 65), with spacing between them, on the second plug-in unit (12, 112, 212) and two cams (28) that are correspondingly arranged on the first plug-in unit (11) and that engage in one of identically configured curved tracks (67).
3. The plug-in connector device as recited in Claim 2, wherein the curved track (67) is configured so as to be generally spiral shaped.
4. The plug-in connector device as recited in Claim 3, wherein the spiral-shaped curved track (67) has a linear access area (71) and a linear end area (75) that is provided with a limit stop, between which are provided areas (73, 74) having varying angles of elevation.

5. The plug-in connector device as recited in any of the preceding claims, wherein the disk elements (64, 65) are furnished with an interior toothing (64', 65') that is facing away from the curved track (67) and that is preferably in the shape of a crown-wheel toothing, which is connected to the toothing of a drive pinion (66) in an interlocking manner. 5
6. The plug-in connector device as recited in Claim 5, wherein the two parallel disk elements (64, 65) are connected in an interlocking manner to the same drive pinion (66) in a crown-wheel configuration. 10
7. The plug-in connector device as recited in Claim 5 or 6, wherein the drive pinion (66) is provided with a tool receptacle (69) that is facing away from the toothing (66') of said drive pinion. 15
8. The plug-in connector device as recited in any of the preceding claims, wherein the two disk elements (64, 65), i.e., crown wheels (64, 65), are each supported in a cutout (61, 62) on two side walls (58, 59), facing each other, of a housing (50, 150), and the drive pinion (66) is supported in a cutout (63) on an end or side wall (60) of the housing (50, 150) that connects the two side walls (58, 59). 20 25
9. The plug-in connector device as recited in any of the preceding claims, wherein the drive pinion (66) has a smaller diameter than the two crown wheels (64, 65), which have the same diameter. 30
10. The plug-in connector device as recited in Claim 8, wherein the housing (50, 150) has a body (49) which is made of electrically conductive material or has an electrically conductive layer, and which is lined using an insulating-material body, within which a blade contact (56) is received which is accessible via an aperture (53, 153) on the longitudinal- or end-wall side. 35 40
11. The plug-in connector device as recited in any of the preceding claims, wherein the cams (28) are supported on parallel wall parts (17, 18) of the first plug-in unit (11), which are arranged with spacing from each other and are elastically deflectable. 45
12. The plug-in connector device as recited in Claim 11, wherein the cams (28) are arranged on latching elements (23, 24), which are each held in a through opening (19) of the wall parts (17, 18) so as to be elastically movable. 50
13. The plug-in connector device as recited in Claim 11 or 12, wherein parallel wall parts (17, 18) are part of a housing body (14) and are provided with a connecting base (15), and the latching elements (23, 24) that are furnished with the cam (28) are supported in the wall parts so that they can latch on the base side. 55
14. The plug-in connector device as recited in at least one of Claims 11 to 13, wherein an insulating-material body (30), within which an electrical contact arrangement (35) is fixedly supported, is arranged between the wall parts (17, 18) of the housing body (14) of the first plug-in unit (11).
15. The plug-in connector device as recited in Claim 14, wherein the electrical contact arrangement (35) is formed by flat spring contacts (36) that are supported in packets in rows on a carrier (40) and that are made up of contact legs (37, 38) that can be elastically pushed apart and are joined to each other so as to form a U-shape, and the contact slot (44) that is formed between the contact legs (37, 38) for the blade contact (56) of a second plug-in unit (12, 112, 212) is accessible through a slot arrangement (34) in the insulating material body (30).
16. The plug-in connector device as recited in any of Claims 11 to 15, wherein between the wall parts (17, 18) of the housing body (14) and the insulating-material body (30) of the first plug-in unit (11) there is an intermediate space, which can accommodate the side walls (58, 59; 158, 159) of a second plug-in unit (12, 112, 212), which are provided with disk elements (64, 65).

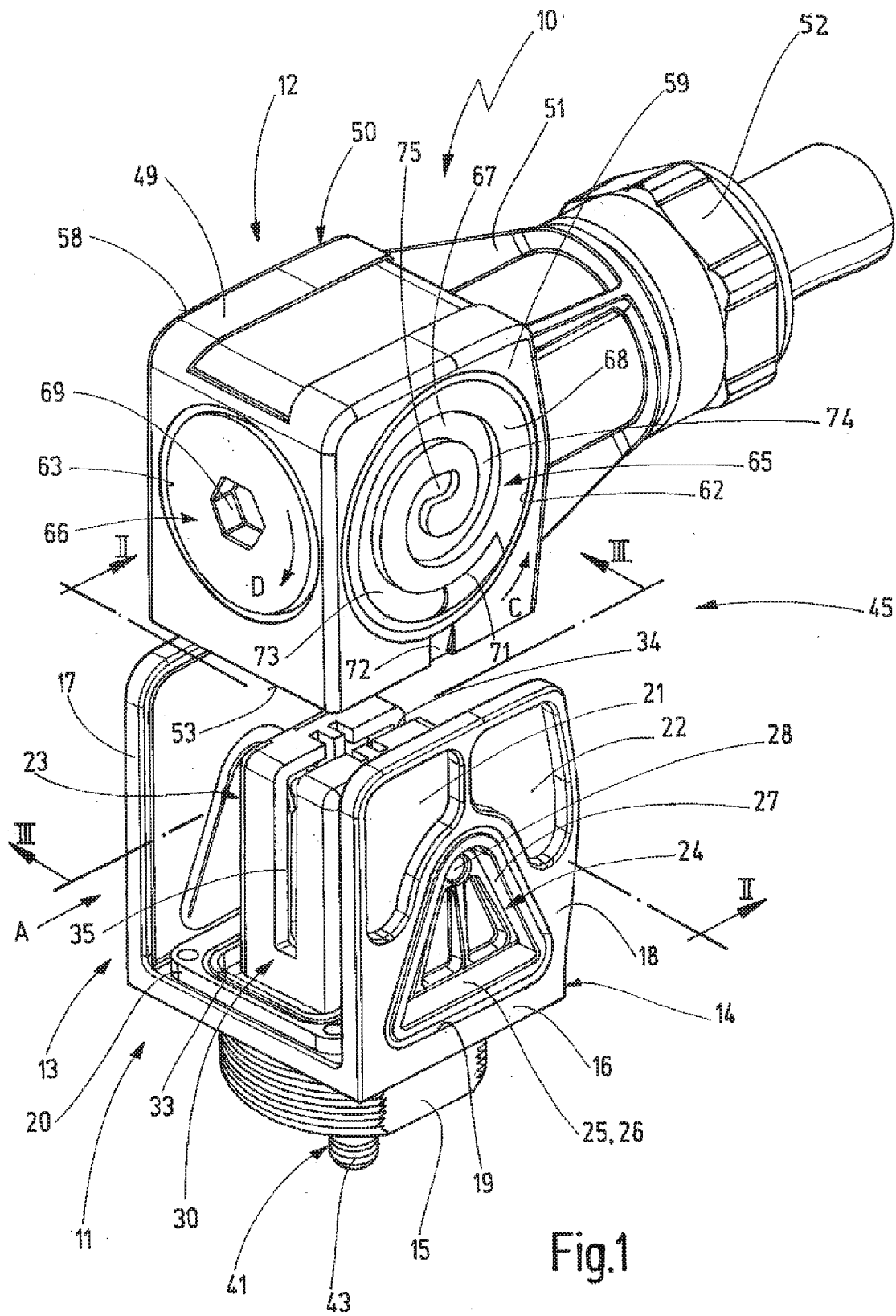


Fig.1

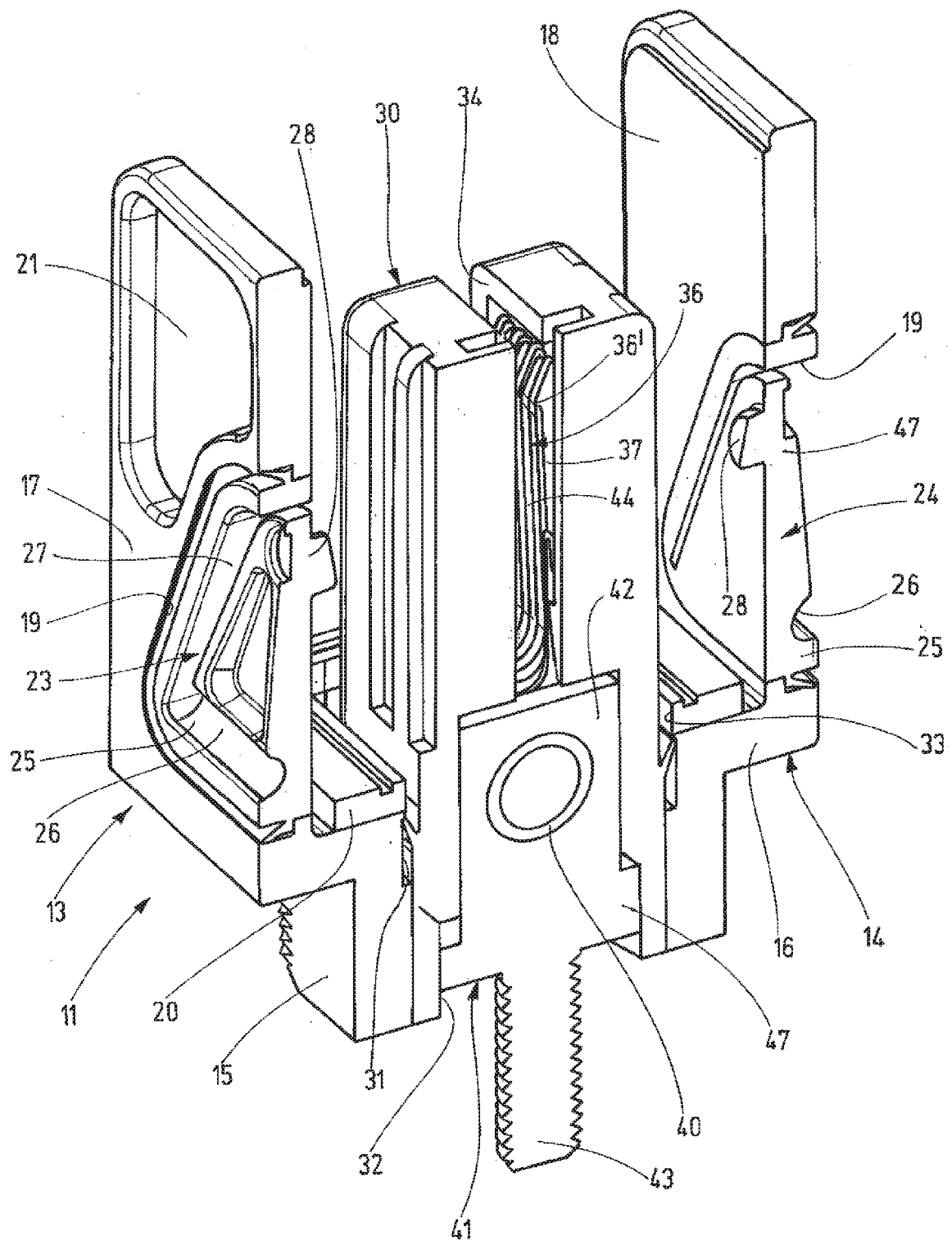


Fig.2

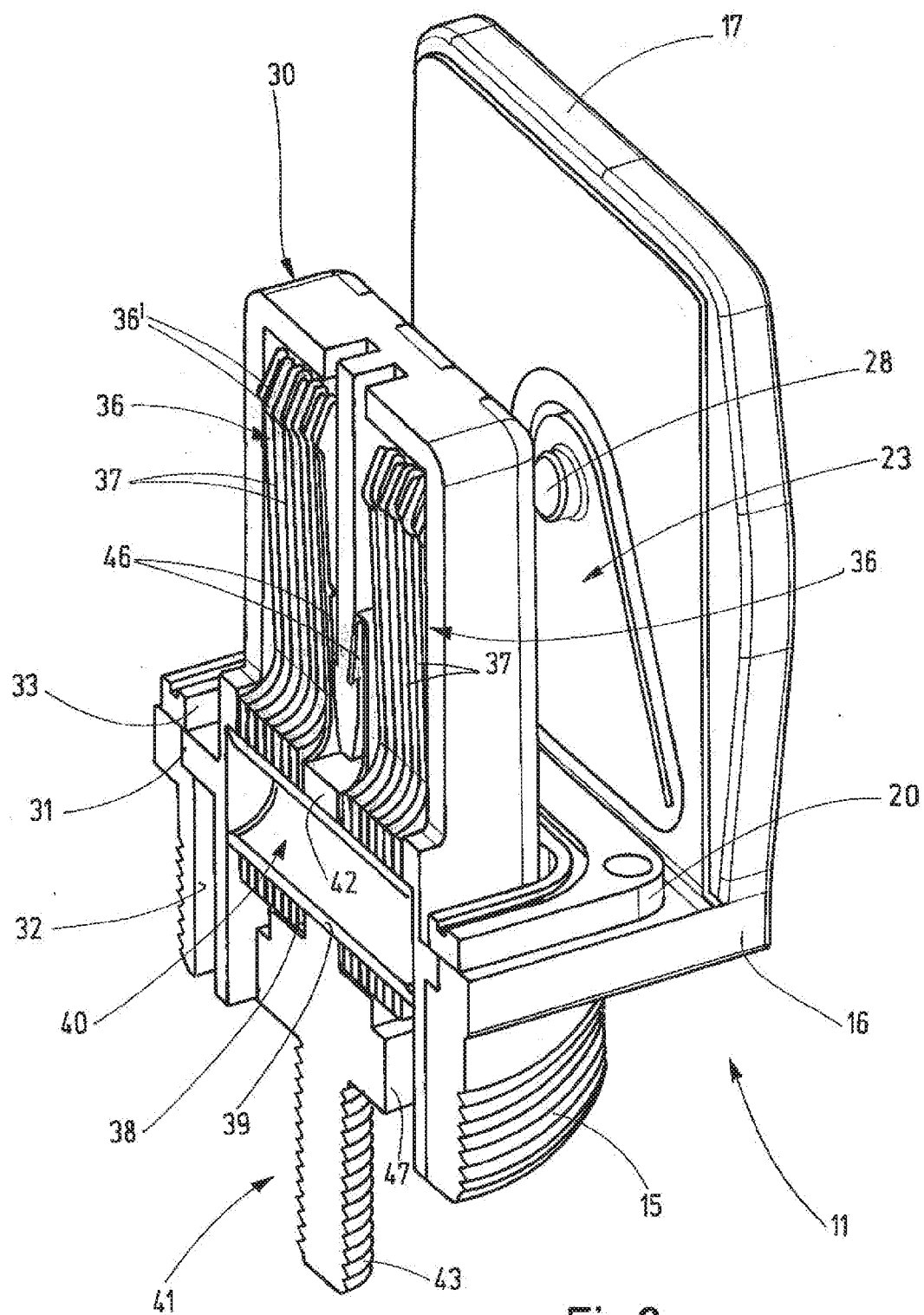
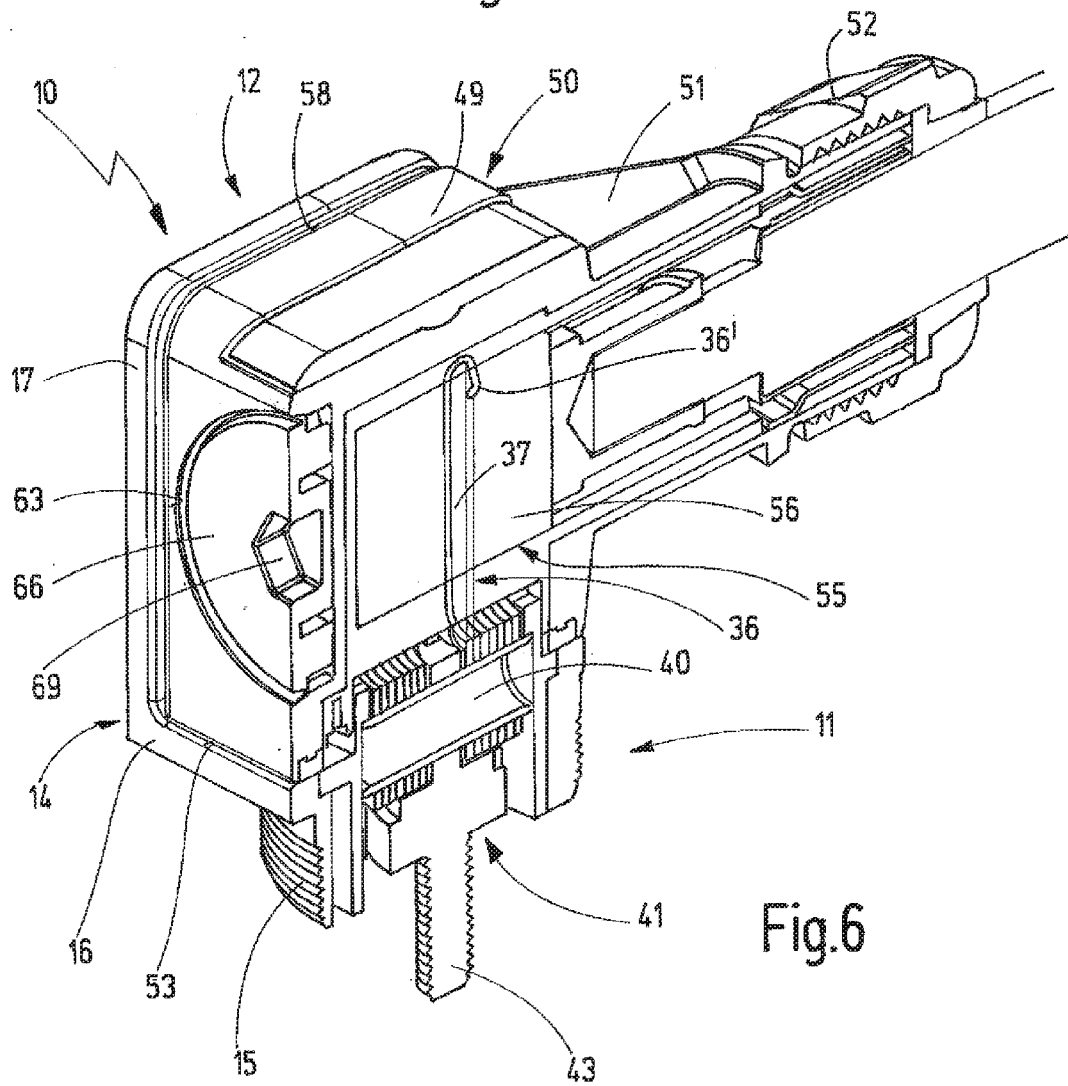
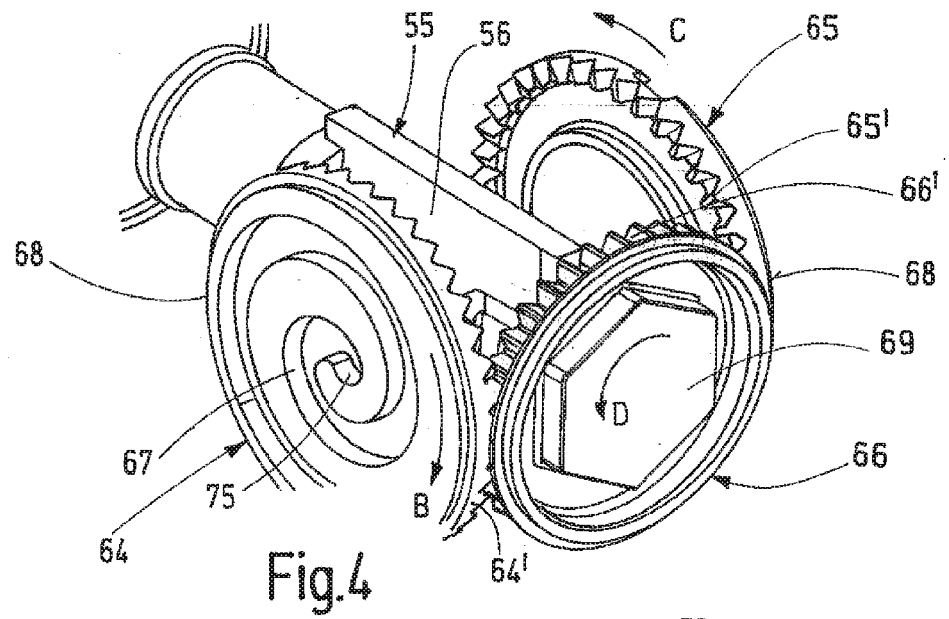


Fig.3



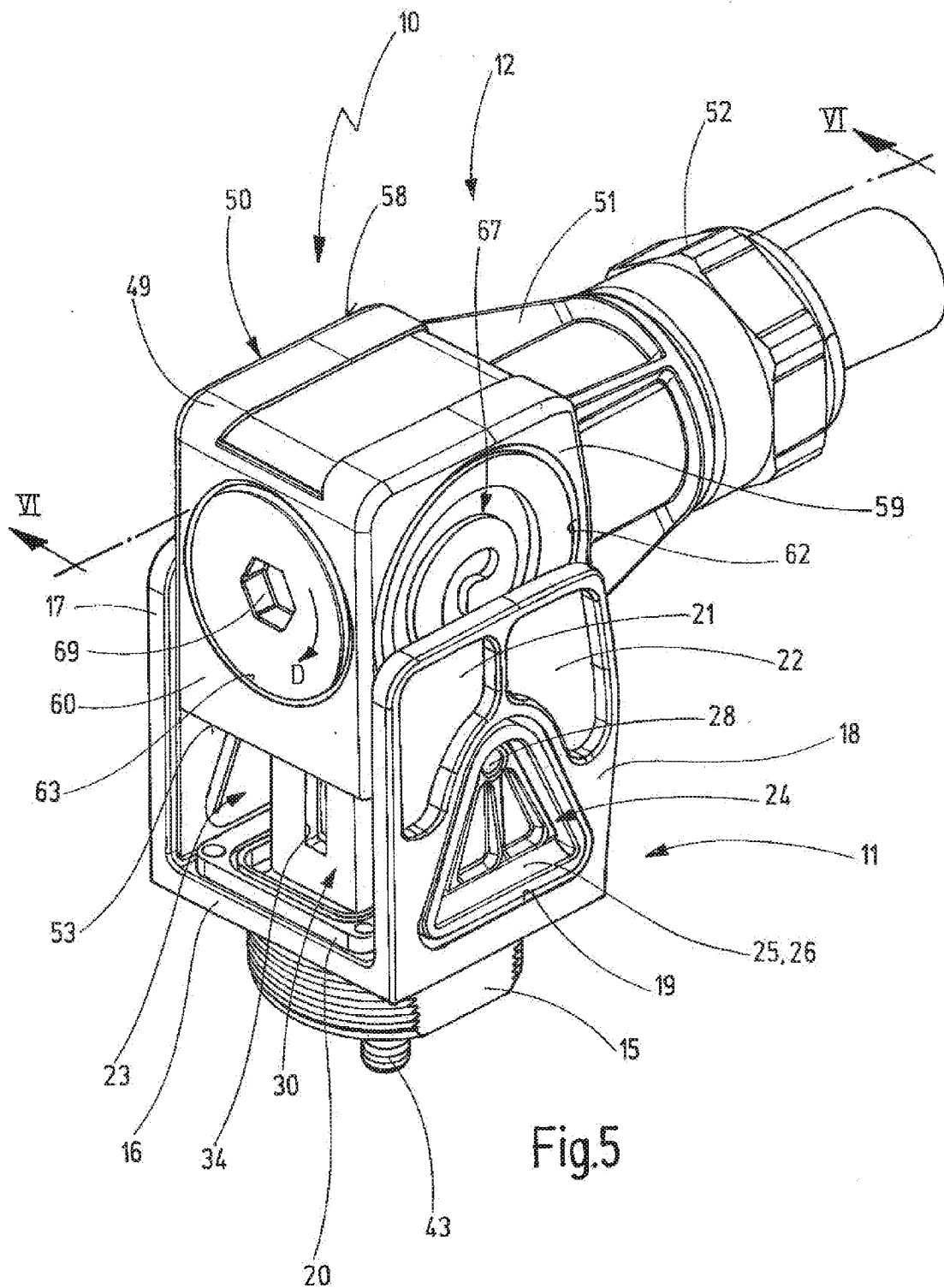


Fig.5

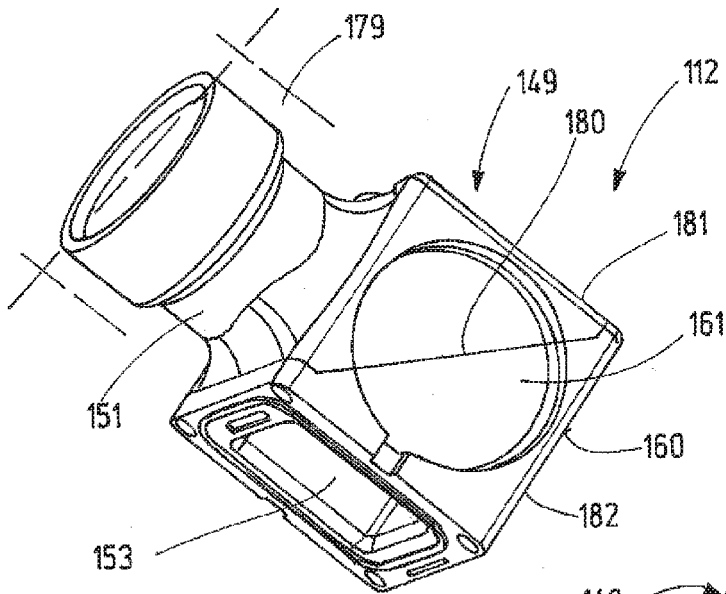


Fig.7A

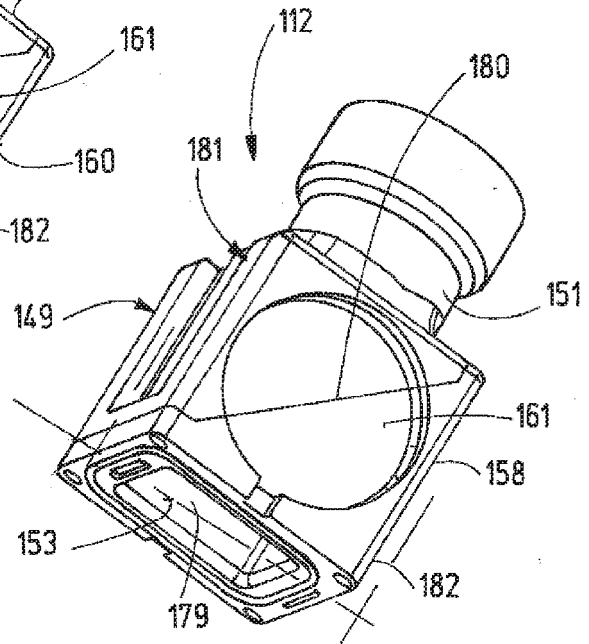


Fig.7B

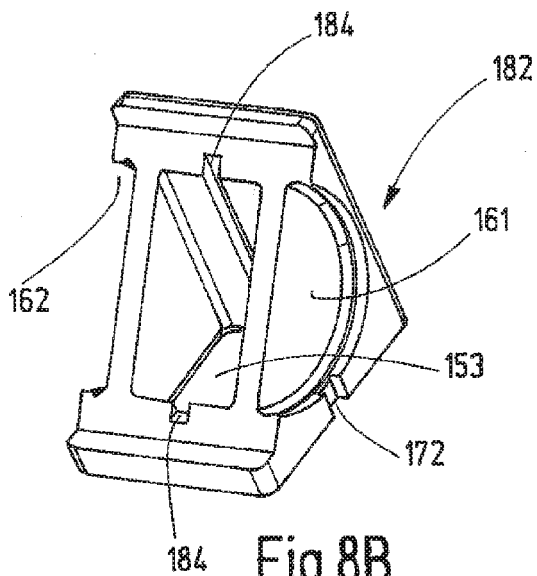


Fig.8B

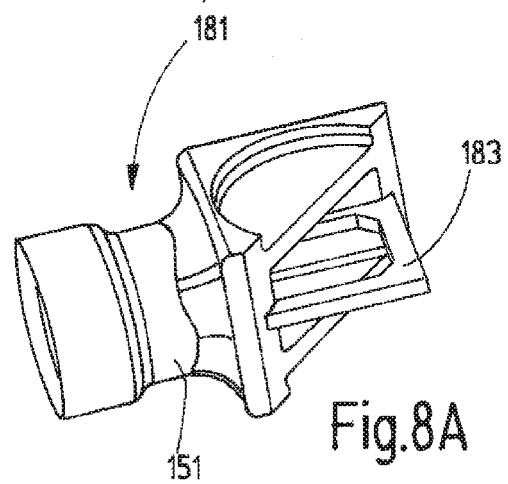
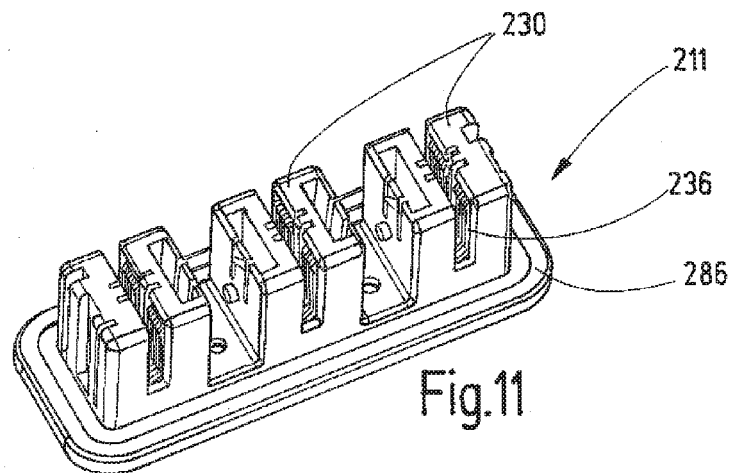
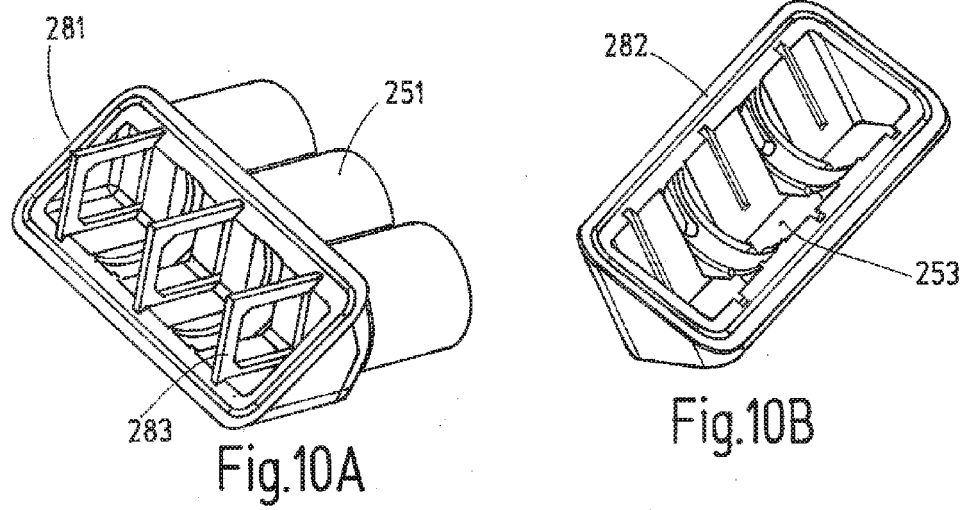
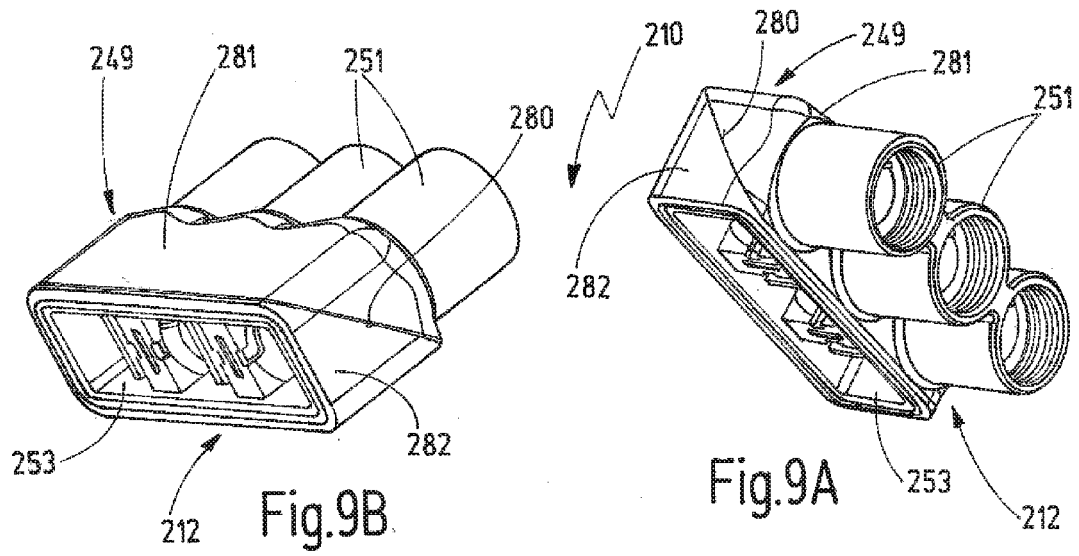


Fig.8A





EUROPEAN SEARCH REPORT

Application Number
EP 11 17 9047

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 7 611 365 B1 (NG JENVUN [US] ET AL) 3 November 2009 (2009-11-03) * column 5, line 18 - column 6, line 38; figures 1-8 *	1-3, 12-16	INV. H01R13/629 H01R107/00 H01R24/60
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